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REGISTRATION OF SOLAR COSMIC RAYS ON THE AMS "LUNA-11"

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SUMMARY

Protons fluxes were measured on LUNA-11 during the late summer 1966 and their relationship with powerful solar flares is established. The results obtained are compared with those on AES "PROTON-3", making it possible to evaluate the spectrum of solar protons at time of measurement.

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The artificial Moon's satellite (AMS) "LUNA-11" was placed into a selenocentrical orbit on 28 August 1966 with the following parameters: aposelion at 1200 km, periselion at 133 km, orbit inclination to the lunar equatorial plane 10°. The communication sessions with the satellite were conducted to 1 October 1966. The apparatus was described in a preceding paper (ref.[1], page 891 of the current issue and ST-PF-IPS-10683). It was operational only at time of communication sessions which were conducted once a day as an average and had a duration from 2 to 40 min.

This work considers the part of the results of measurements having to do with the general variation in time of proton flux in two energy intervals: 1.8 – 100 Mev (3rd threshold of the scintillation counter) and E_p > 50 Mev (STS-5 counter). Note that for solar protons having a steeply dropping spectrum, these intervals correspond practically to two points of the integral spectrum: E_1 > 1.8 Mev and E_2 > 50 Mev. The intensity of galactic cosmic ray protons in the 1.5 – 100 Mev range is too low for its registration by our apparatus.

Fig.1 next page illustrates the variation in time of the intensity of protons with E_p > 50 Mev and E_p > 1.8 Mev (mean value for each session). The galactic cosmic rays, whose intensity constituted according to our measurements 3.8 cm^{-2} sec^{-1}, enter the first group (E_p > 50 Mev).

(*) REGISTRATSIYA SOLNECHNYKH KOSMICHESKIKH LUCHEY NA ISL "LUNA-11"

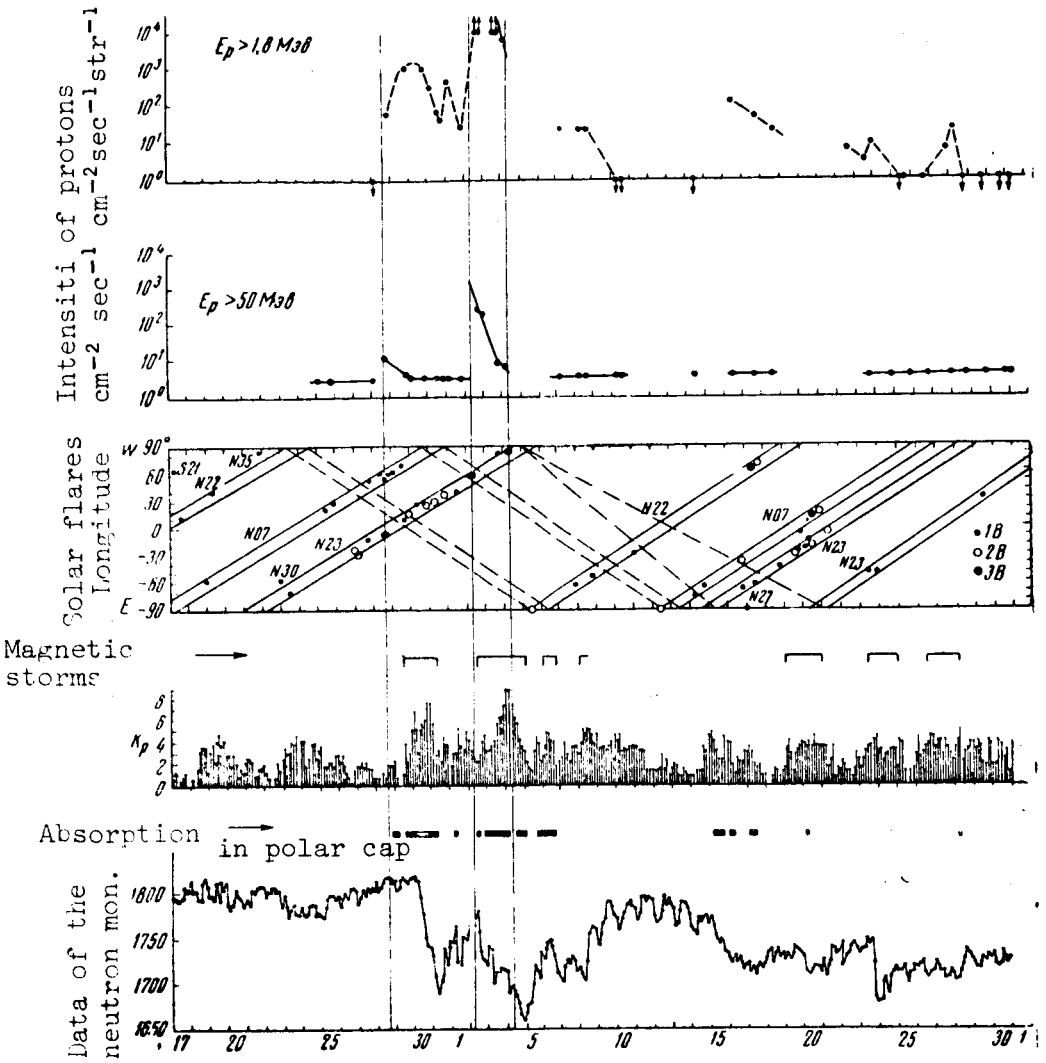

Fig.1

Plotted above is the intensity of protons with E_p > 1.8 Mev and E_p > 50 Mev. In the middle are the moments and the heliocentrical coordinates of the most powerful flares of force 1B, 2B, 3B and also the graphs of active regions' motion along the Sun's disk. Still further below are certain geophysical parameters linked with the solar activity

As may be seen from Fig.1, most of the time the intensity of protons with E_p > 50 Mev corresponds to galactic background. Two significant intensity increases were registered only on 28 August and 2 September. In the latter case the intensity exceeded the background by two orders. As to the intensity of protons with E_p > 1.8 Mev, it underwent large fluctuations, emerging at times beyond the limits of device's dynamic band, whereupon the maximum values of intensity were observed with a lag from a few hours to 1.5 days by comparison with the maxima of protons with E_p > 50 Mev.

Plotted at the center of Fig.1 are graphs of motion of active regions according to the visible disk of the Sun (longitude as a function of time) and the coordinates of the most powerful flares. The latitudes of active regions did not practically vary in the course of two consecutive passages. Two intervals with high solar activity were observed during measurement time: from 28 August to 4 September and from 17 to 21 September. These increases in activity were caused by the passage along the Sun's disk of three long-lived active regions with latitudes N 22°, N 07° and N 23°. The last region apparently split into two parts after the first passage. More than 90% of the registered flares of force 1B, 2B and 3B took place in these regions, whereupon the most active was the region N 23°. It may be see from the graph that the increases in intensity of protons with E_p > 50 Mev followed on 28 August and 2 September flares of force 3 B in the active region N 23°. Note that measurements of 28 August were conducted 3 hours after the commencement of optical flare, while on 2 September they were conducted only after 14 hours. Nevertheless in the second case the intensity of protons was was by one order greater. The significantly greater effect from the second flare may be explained by the fact that the disposition of the flare of 2 September (W 60°) was more favorable for the arrival of protons in the neighborhood of the system Earth Moon.

In the lower part of the same Fig.1 we brought out the values of the K_p-index and the readings of the neutron monitor (Moscow, three-hourly averages) and we noted the magnetic storms and radiowave absorptions in the polar cap. It may be seen that the flares of 28 August and particularly that of 2 September were attended by powerful geomagnetic disturbances and Forbush-drops, which correlate quite well with the intensity variations of protons in the vicinity of the Moon.

The third, quite as strong a flare took place at the limb on 4 September in the considered region N 23°. The nearest communication session after that flare was only on 7 September; however, comparison of our measurements with the geophysical data allows us to assume that the effect from protons of that flare was lesser than during the flare of 2 September. Just as for the flare of 28 August, this case agrees well with the representations on the interplanetary magnetic field, of which the lines of force are curved along the Archimedes' spiral.

Simultaneously with the measurements on LUNA-11, others were conducted aboard AES "PROTON-3" and concentrated on protons with E_p > 400 Mev. No intensity increase above the cosmic background ($\sim$ 10% of background) was observed in the period after the flares of 28 August and 2 September. Comparing these

data with the results obtained on LUNA-11, it is possible to evaluate the character of the spectrum of solar protons at time of measurement. If we assume for the integral spectrum of protons the law $N(E) \sim E^{-\gamma}$, we shall obtain for γ the values $\gamma_1 > 1$ and $\gamma_2 > 1.7$ for the 28th of August and 2nd September respectively.

The intensity of protons with $E_p > 50$ Mev from the flare of 2 September varied as $N \sim t^{-3.4}$ (the time is counted from the commencement of the optical flare). The estimate of the integral flux of protons based upon this dependence on t and on various assumptions on the times of flux maximum, fluctuates from 10^8 to 10^9 cm^{-2}, which corresponds to the absorbed dose of protons with $E_p > 50$ Mev from 10 to 100 rad.

During the second passage of active regions through the visible disk of the Sun the greatest activity was registered in the period from 17 to 21 September. At this time the most powerful flares (3 B) were observed in the active regions N 22° and N 07°. Although by their power and disposition these flares are close to the flares of 28 August and 2 September, their proton effectiveness is substantially lesser. We observed an intensity increase only for protons with $E_p > 1.8$ Mev [1]. The intensity of protons with $E_p > 50$ Mev was close in all sessions to the galactic background. The readings of the neutron monitor and the geomagnetic data also attest to the lesser effectiveness of the flares of 17 –21 September.

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**** T H E E N D ****

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REFERENCES

[1]. N. L. GRIGOROV, V. N. LUTSENKO ET AL. CURRENT ISSUE. (ST–PF–IRS–10683).

[2]. J. J. O'GALLAGHER, J. A. SIMPSON. Phys. Rev. Letters 16, 1212, 1966.

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